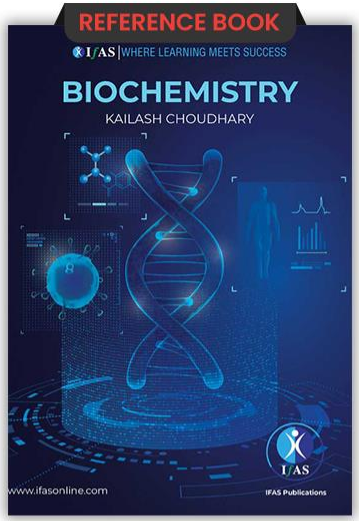
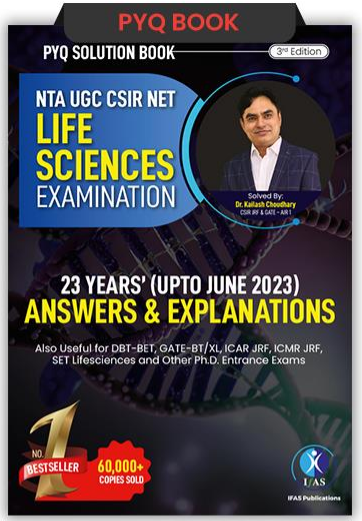
आज अगर आप 6 घंटे पढ़ने के लिए तैयार नहीं हो सकते
तो कल आपको 12 घंटे काम करने के लिए तैयार रहना होगा!

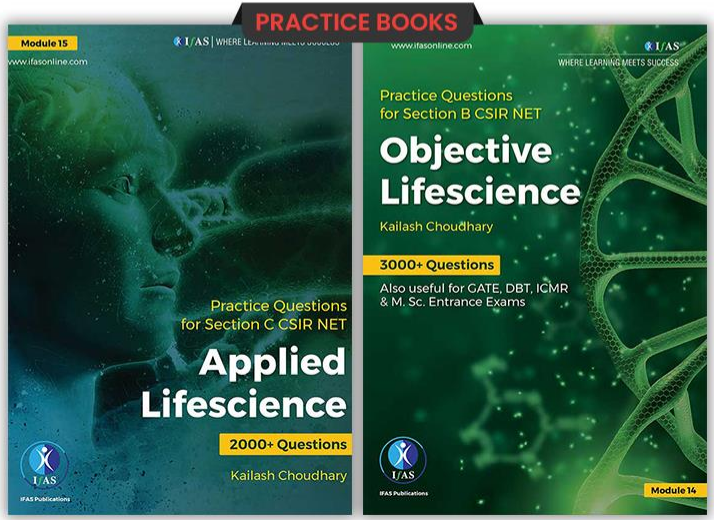
CSIR NET – Life Science

Unit 1: Biochemistry

07 **Lipids and Nucleotides**







IfAS

Order Online and Get
Free Delivery Across India

Points to be covered in this Lecture

- What are Lipids?
- Fatty Acids
- Simple Lipids
- Glycerol Based Lipids
- Sphingosine Based Lipids
- Cholesterol
- Nitrogenous Bases
- Nucleoside and Nucleotides

Lipids are esters of fatty acids and polyhydroxy alcohol.

1 2

Simple lipids are the compounds of C, H, O but the ratio of H and O is more than 2:1

C : H >> O

1 : 2

Their general formula is $C_nH_{2n}O_2$.

- Non-polar
- Macromolecule
- Not true polymer

Preferred Energy Storage molecule:

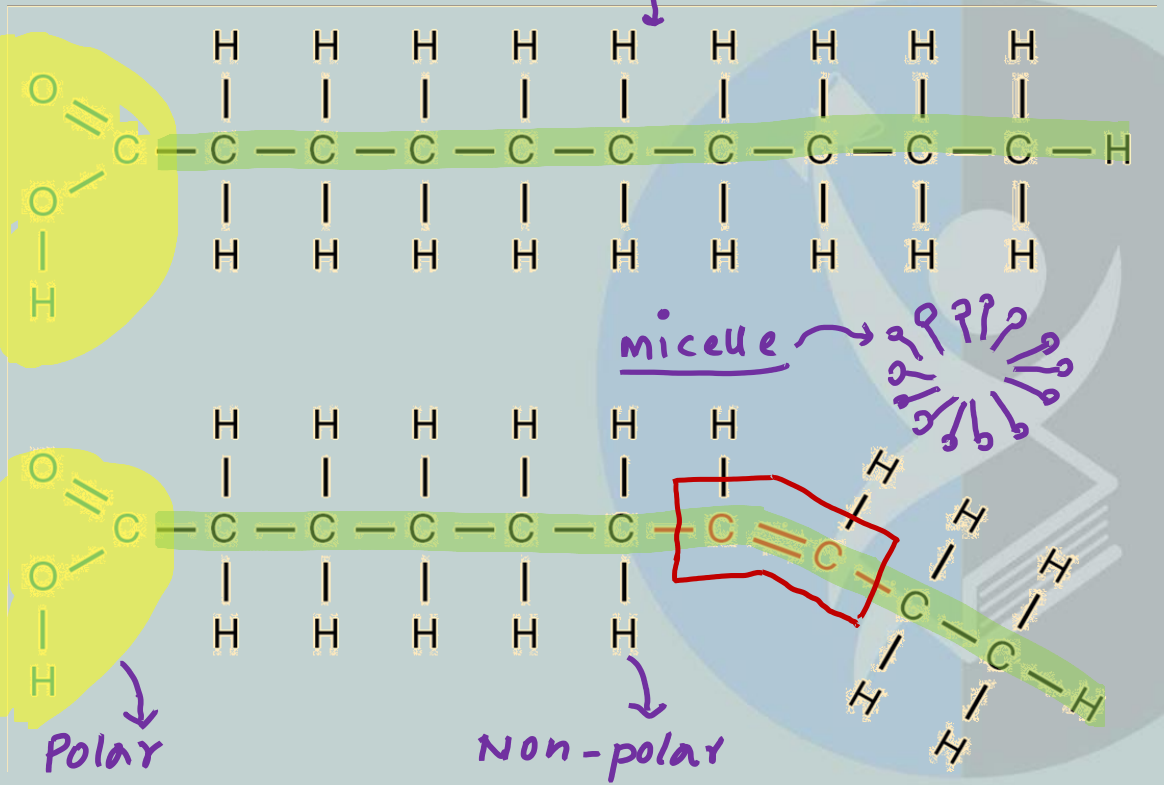
- Lipids represent highly reduced forms of carbon and,
- Lipids upon oxidation yield large amounts of energy.
- Lipids are choice for **metabolic energy storage.**
- Preferred for **marathon runner**

- **Lipid are composed of**
  - **Fatty Acids**
  - **Polyhydroxy Alcohol**

- Carbohydrate 4 K.cal/g
- Protein 4.2
- Lipids 9 K.cal/g

* occupy lesser space

1. Fatty Acids: Aliphatic chain with Acidic Group



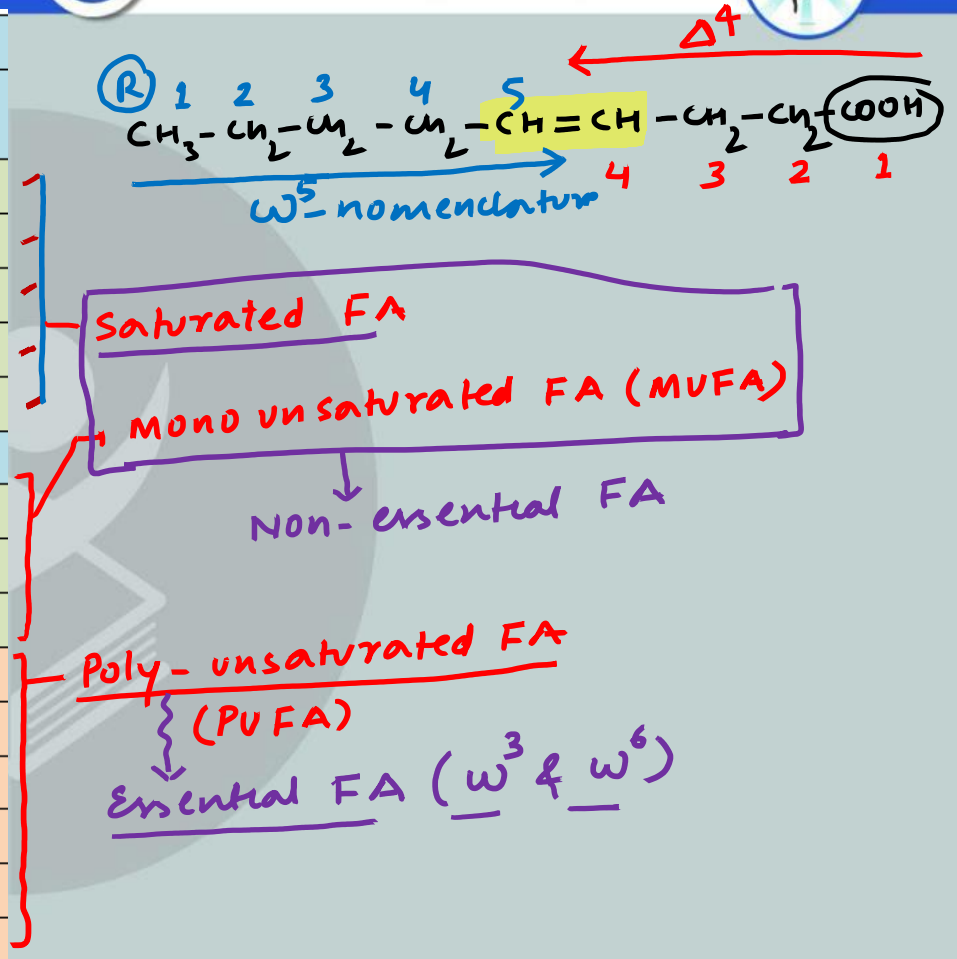
Saturated Fatty Acid

- Only single bonds
- Completely Reduced
- Yield more energy

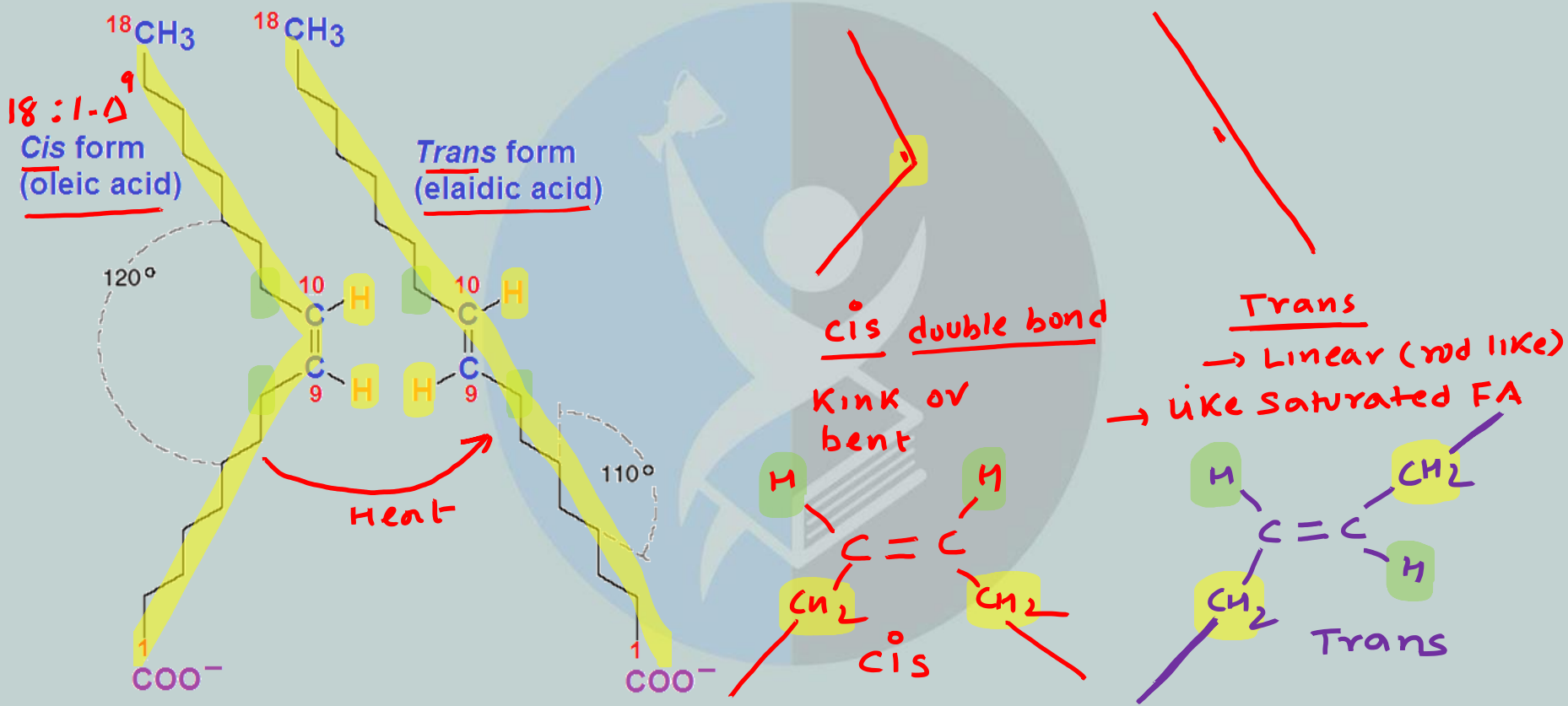
Unsaturated Fatty Acid

- 1 or more double bond
- Partially oxidized.

Saturated fatty acids			
Formula		Common Name	Melting Point
$CH_3(CH_2)_{10}COOH$	12C	Lauric acid	45 °C
$CH_3(CH_2)_{12}COOH$	14C	Myristic acid	55 °C
$CH_3(CH_2)_{14}COOH$	16C	Palmitic acid	63 °C
$CH_3(CH_2)_{16}COOH$	18C	Stearic acid	69 °C
$CH_3(CH_2)_{18}COOH$	20C	Arachidic acid	76 °C
Unsaturated fatty acids			
16:1 Cis-Δ^9	ω^7	Palmitoleic acid	0 °C
18:1 Cis-Δ^9	ω^9	Oleic acid	13 °C
18:1 Trans-Δ^9	ω^9	Elaidic acid	45 °C
18:2 Cis-$\Delta^{9,12}$	ω^6	Linoleic acid	- 5 °C
18:3 Cis-$\Delta^{6,9,12}$	ω^6	γ- Linolenic acid	- 11 °C
18:3 Cis-$\Delta^{9,12,15}$	ω^3	α- Linolenic acid	- 17 °C
20:4 Cis-$\Delta^{5,8,11,14}$	ω^6	Arachidonic acid	- 49 °C
20:5 Cis-$\Delta^{5,8,11,14,17}$	ω^3	Timnodonic acid	- 69 °C
22:6 Cis-$\Delta^{4,7,10,13,16,19}$	ω^3	Cervonic acid	- 92 °C



Cis-double bonds are more preferred in naturally occurring unsaturated fatty acids



Saturated fatty acids			
Formula		Common Name	Melting Point
$CH_3(CH_2)_{10}COOH$	12C	Lauric acid	45 °C
$CH_3(CH_2)_{12}COOH$	14C	Myristic acid	55 °C
$CH_3(CH_2)_{14}COOH$	16C	Palmitic acid	63 °C
$CH_3(CH_2)_{16}COOH$	18C	Stearic acid	69 °C
$CH_3(CH_2)_{18}COOH$	20C	Arachidic acid	76 °C
Unsaturated fatty acids			
16:1 Cis-Δ^9	ω^7	Palmitoleic acid	0 °C
18:1 Cis-Δ^9	ω^9	Oleic acid	13 °C
18:1 Trans-Δ^9	ω^9	Elaidic acid	45 °C
18:2 Cis-$\Delta^{9,12}$	ω^9	Linoleic acid	- 5 °C
18:3 Cis-$\Delta^{6,9,12,}$	ω^6	γ- Linolenic acid	- 11 °C
18:3 Cis-$\Delta^{9,12,15}$	ω^3	α- Linolenic acid	- 17°C
20:4 Cis-$\Delta^{5,8,11,14}$	ω^6	Arachidonic acid	- 49 °C
20:5 Cis-$\Delta^{5,8,11,14,17}$	ω^3	Timnodonic acid	- 69 °C
22:6 Cis-$\Delta^{4,7,10,13,16,19}$	ω^3	Cervonic acid	- 92°C

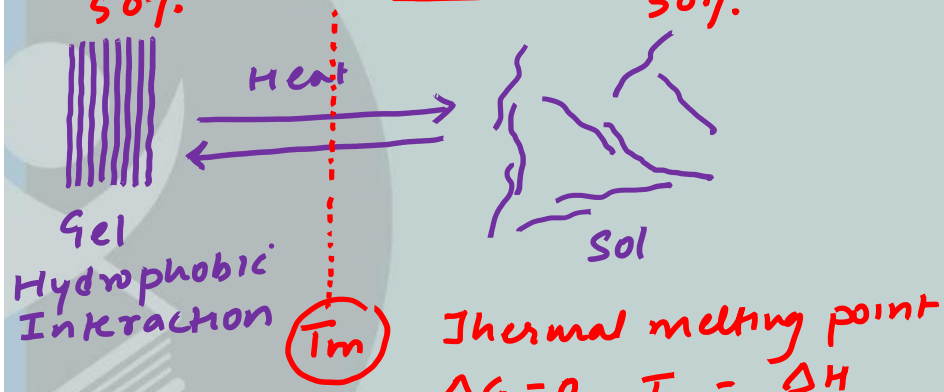
Increase

Decrease

The melting point (Tm) of fatty acids,

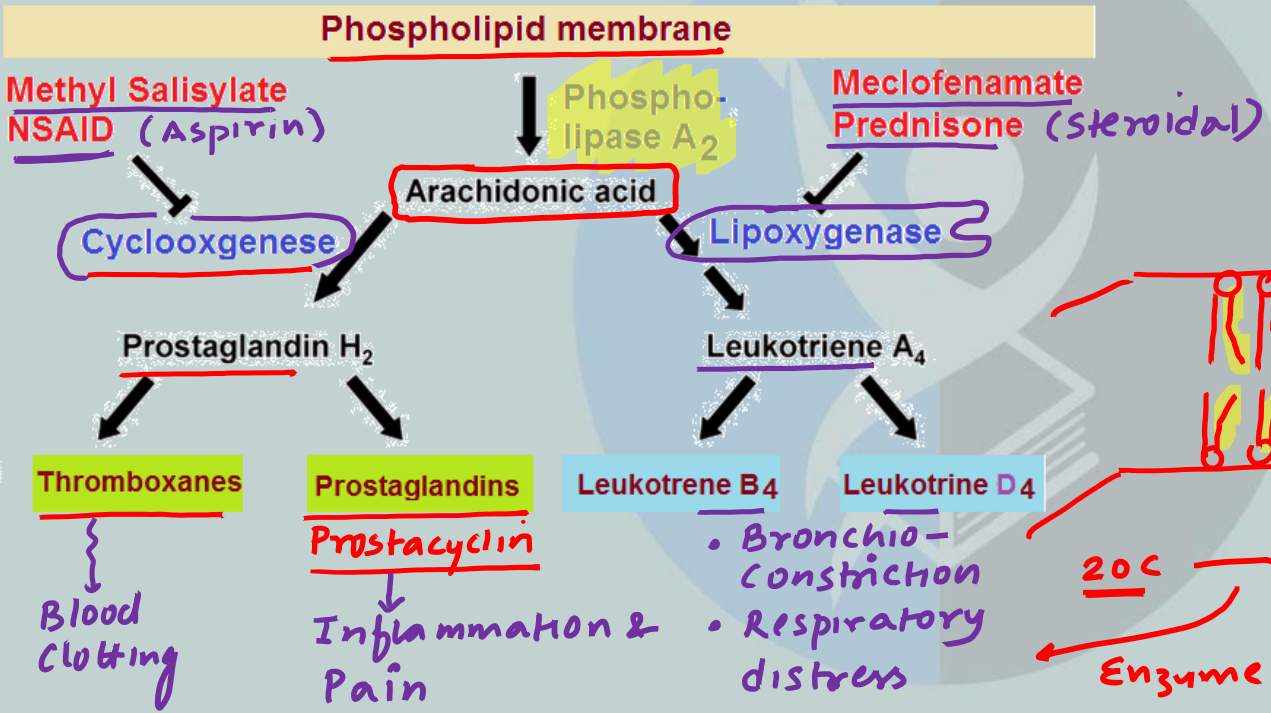
1 increases with chain length and

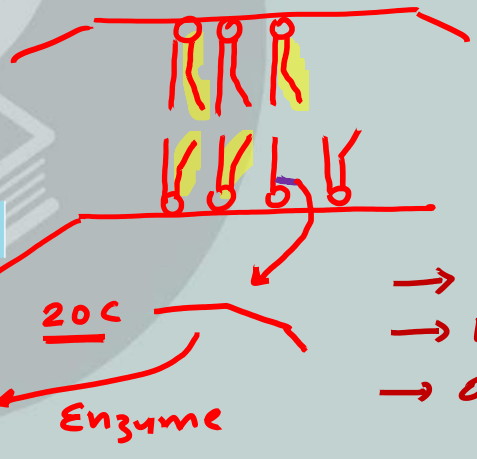
2 decreases with the degree of (cis)-unsaturation.



Eicanosoids: 20 carbon derivative.

Arachidonic acid, 20 carbon units derivative





PUFA are essential

- cannot be synthesized by animals but are important for various physiological function.
- obtained from diet

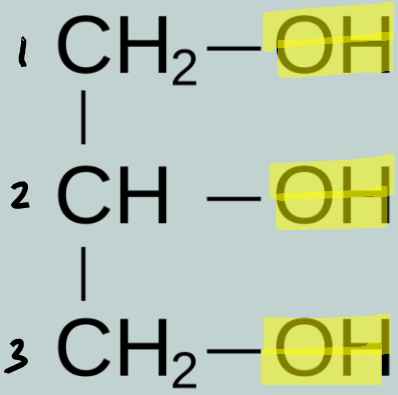
- Thromboxane
- Prostoglandin
- Prostacyclin
- Leukotriene

Eicanosoids

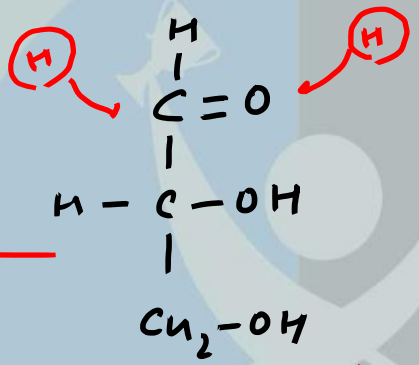
→ Local hormone
→ Half life - Low
→ GPCR family receptors

Polyhydroxy Alcohol- Glycerol : Polar

Derived from reduction of Glyceraldehyde



Glycerol



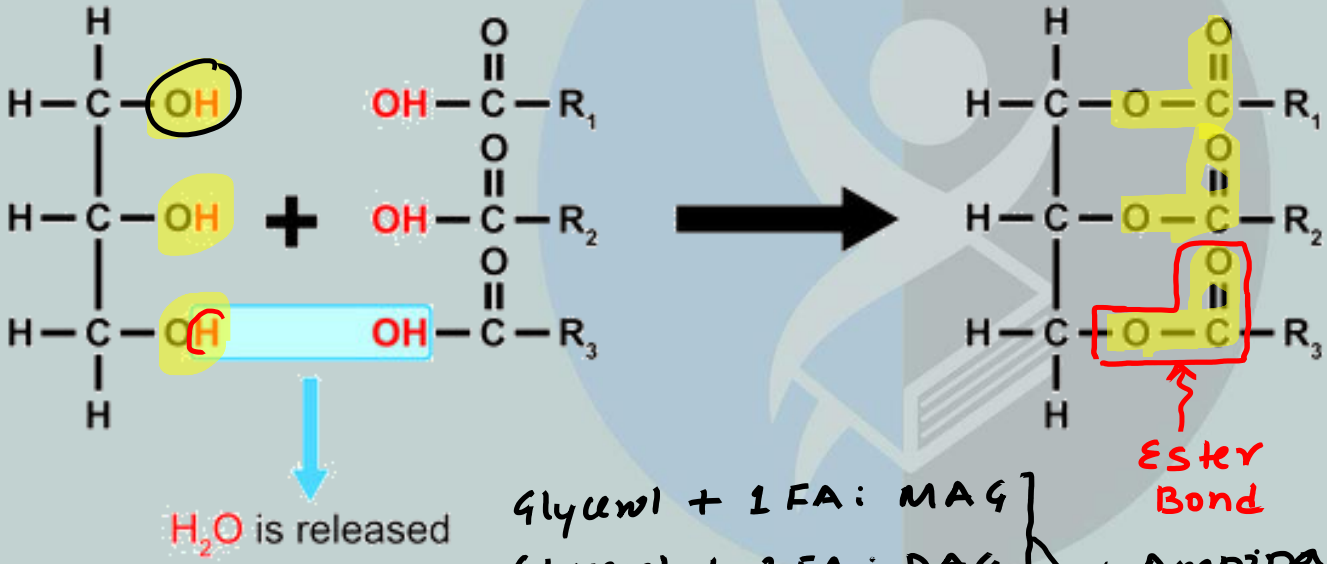
D. Glyceraldehyde

Fats and oils (Tri-Acyl Glycerol): Ester of Fatty Acid and Glycerol

- Donot form membrane
- Non-polar.
- Tri-Acyl Glycerol (TAG)
- Energy storage form

Fat → Animals
Oil → plant

Glycerol ✓ + 3 Fatty Acids ✓ → Triglycerides + $3H_2O$

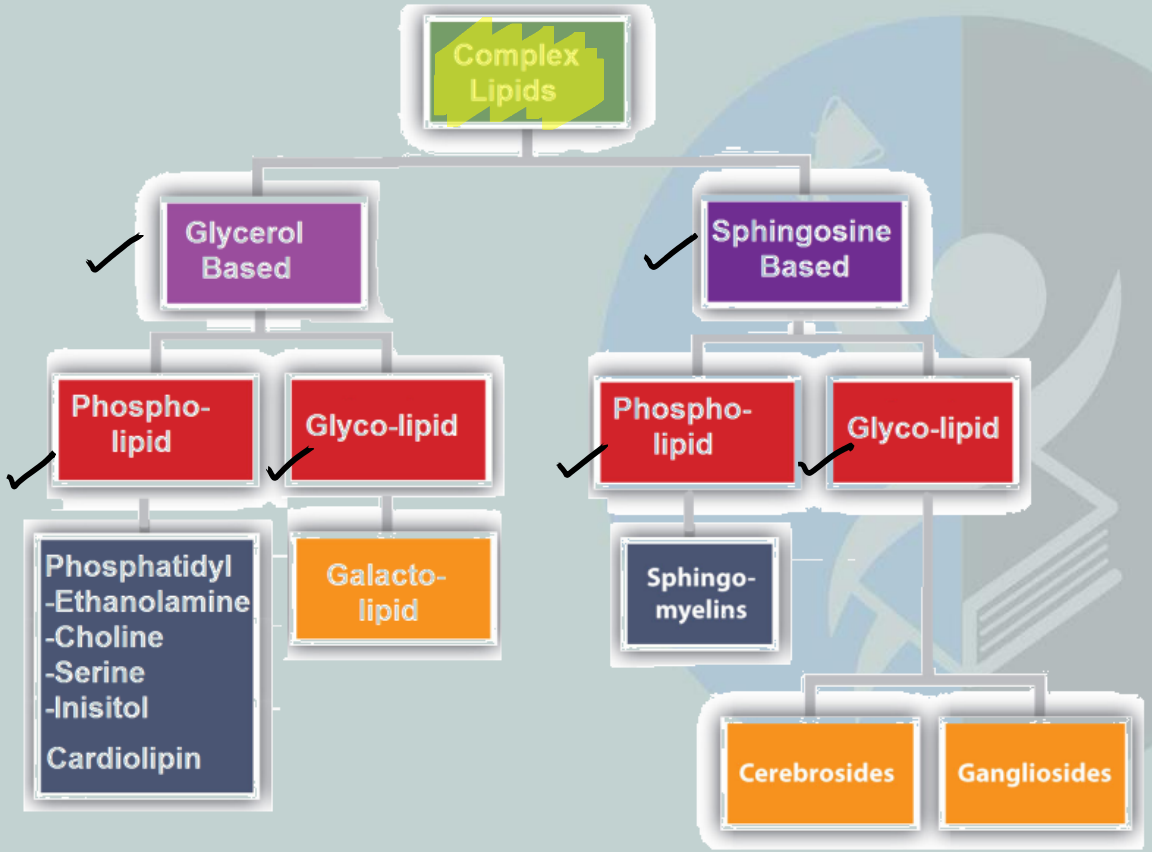


Glycerol + 1 FA : MAG
Glycerol + 2 FA : DAG
→ Ampipathic molecule

Membrane lipids are derived Lipids

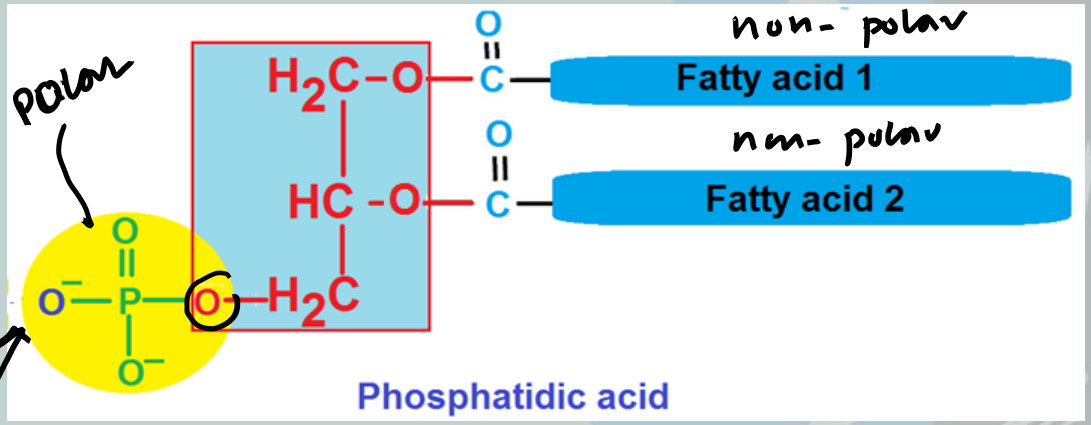
→ FA + Polyhydroxy Alcohol + Extra group

Extra group: Phosphate, Sugar



A. Glycero-phospholipids

Derivatives of **phosphatidic acid**.



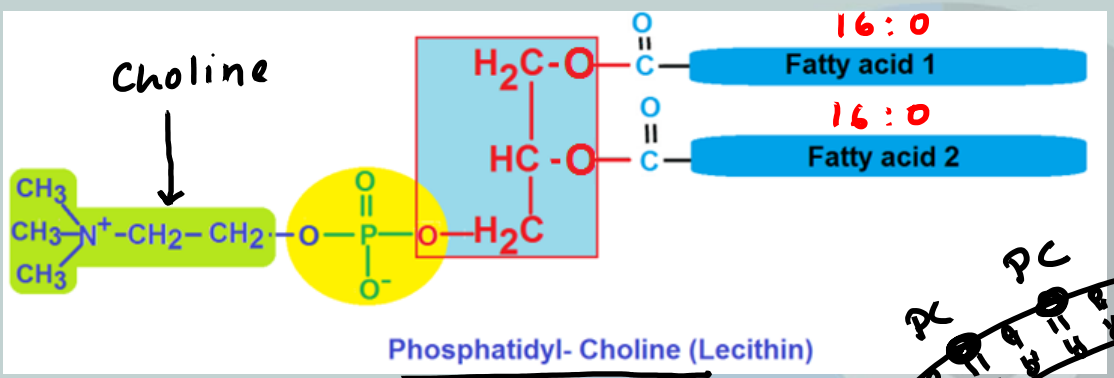
Extra Group

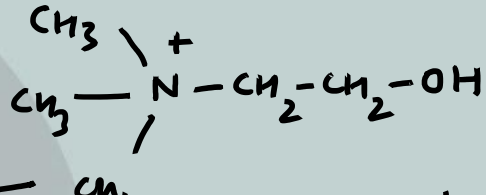
1 glycerol + 2 FA + 1 phosphate

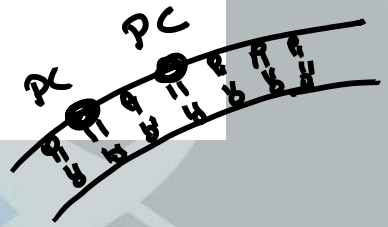
Polar
non-polar
} Amphi-pathic

Synthesis : SER in eukaryotes or plasma membrane of bacteria

Phosphatidyl-choline (lecithin): 1 choline + 1 phosphate + 1 glycerol + 2 FA







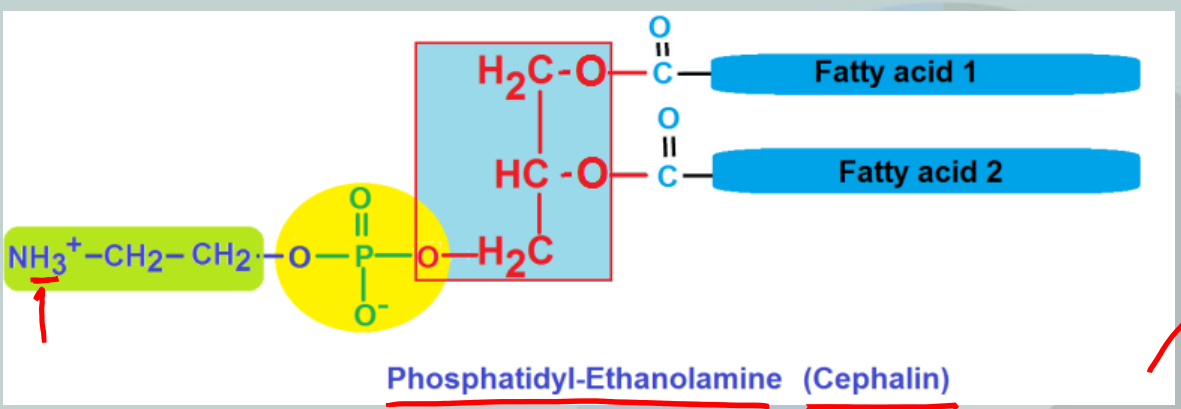
Dipalmitoyl Phosphatidyl Choline (DPPC)

Dipalmitoyl lecithin: surfactant

- Produced by Type II alveolar epithelial cells (pneumocytes) ← lung alveoli
- Absence of surfactant leads to Respiratory distress syndrome.

Phosphatidylethanolamine (cephalin):

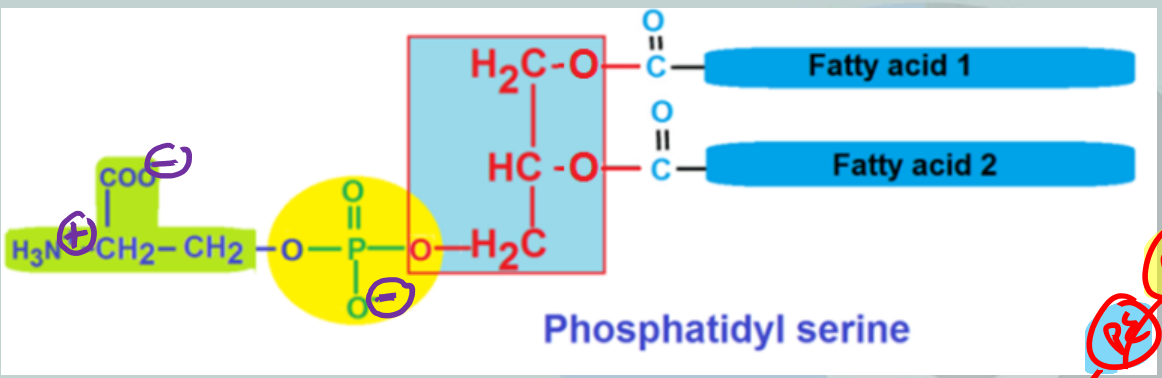
1 ethanolammé + 1 phosphate
+ 1 glycerol
+ 2 Fatty acid



PE PE PE

- Abundant in bacterial membrane

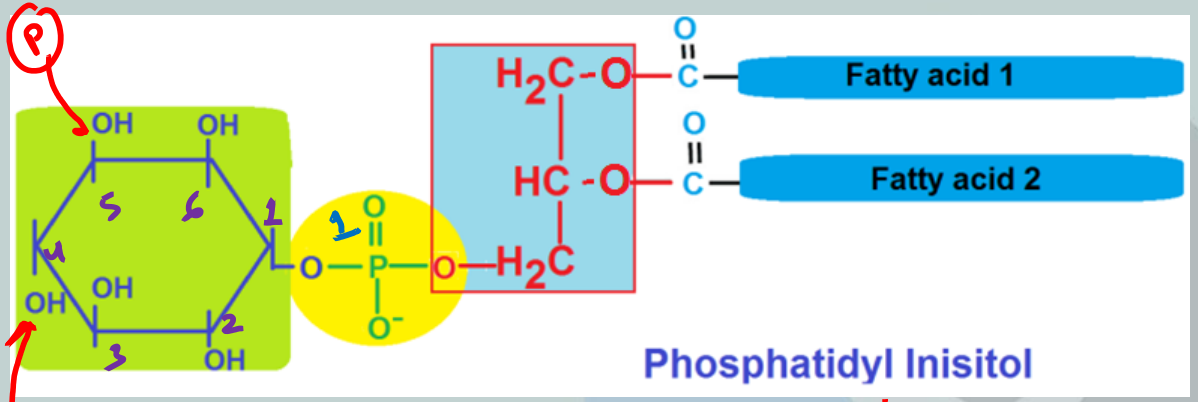
Phosphatidyl serine: 1 serine + 1 phosphate + 1 glycerol + 2 FA



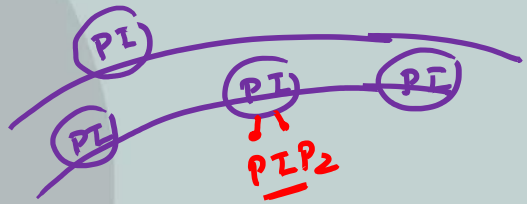
- Present on cytosolic face of membrane
- PS if on outerside – eat me signal
  – Apoptic cell.

→ PS can be recognized by Annexin-V protein

Phosphatidylinositol: 1 Inisitol + 1 Phosphate + 1 glycerol + 2 FA



- Present more on cytosolic face



ATP → ADP

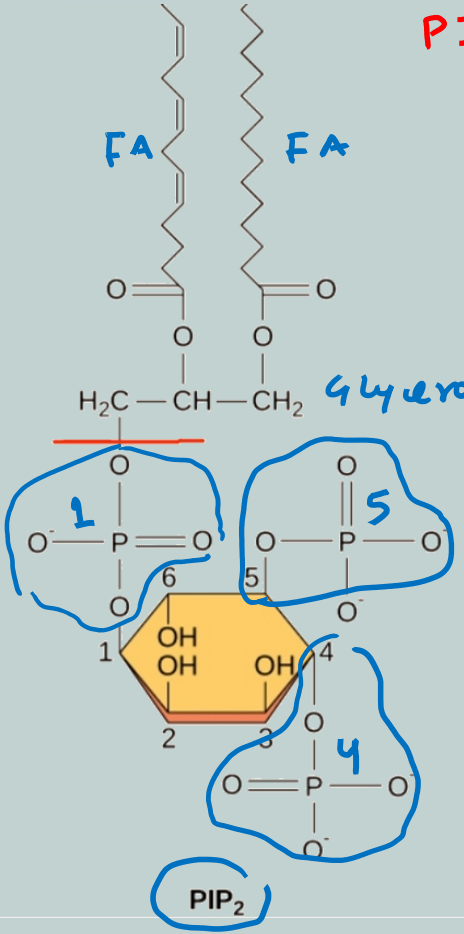
Add Phosphate Group on 4th & 5th Position of Inisitol

← PI-4 Kinase
← PI-5 Kinase

Phosphatidyl Inisitol 4,5 Bis Phosphate (PIP_2)

PIP_2 —PI-3 Kinase→ PIP_3 (secondary messenger) ⊕→ cell survival

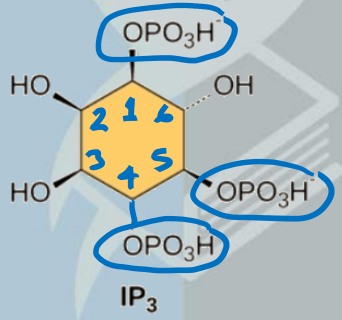
PIP_2 —PL-C→ DAG + IP_3



Phospholipase C

activate Protein Kinase C along with Ca^{2+} ions.

\+ Secondary messenger

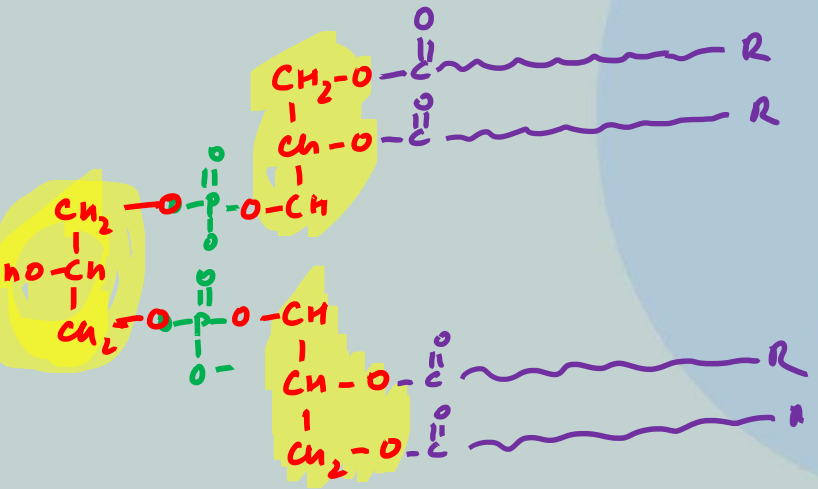


opens ligand (IP_3) gated Ca^{2+} channel of ER.

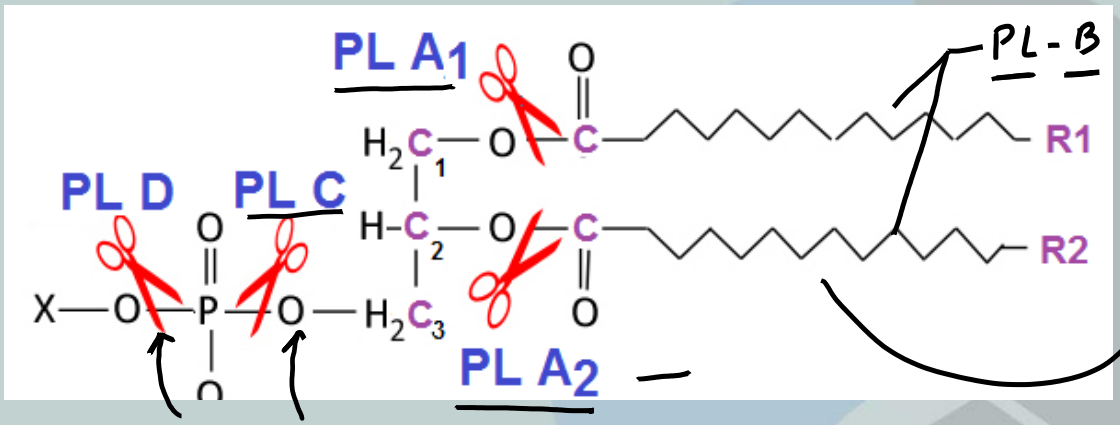
Inositol 1,4,5 Tris Phosphate (IP_3)

Cardiolipin (Diphosphatidylglycerol):

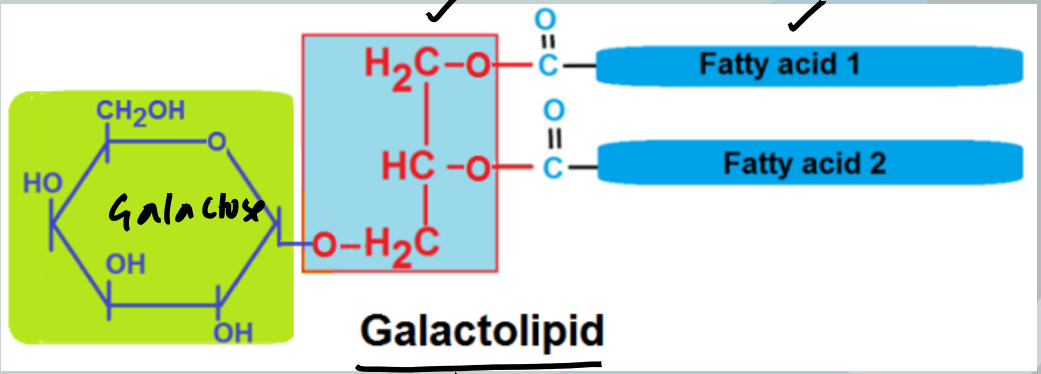
- Unique membrane lipid of inner mitochondrial membr and bacterial plasma membrane
- 3 glycerol + 2 phosphate + 4 Fatty acid
- Diphosphatidyl glycerol



Rattlesnake and the **Indian cobra** (*Naja naja*) : ***Phospholipase A2,***



B. Glycerol based glycolipids:



Galactolipid

- 1 Galactose +
- 1 Glycerol +
- 2 FA

↓

- Galactolipid

Galactolipid

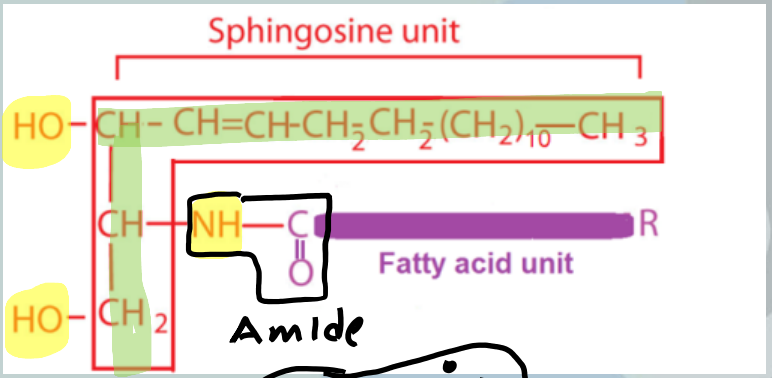
↳ Absent in plasma membrane

↳ Thylakoid membrane of chloroplast.

- Galactolipid
- Sulpholipids.

C. Phospho-sphingolipids:

Sphingosine : 18 carbon poly hydroxy amino alcohol.



1 Sphingosine + 1 FA
↓ Amide
Ceramide
(Resembles DAG)

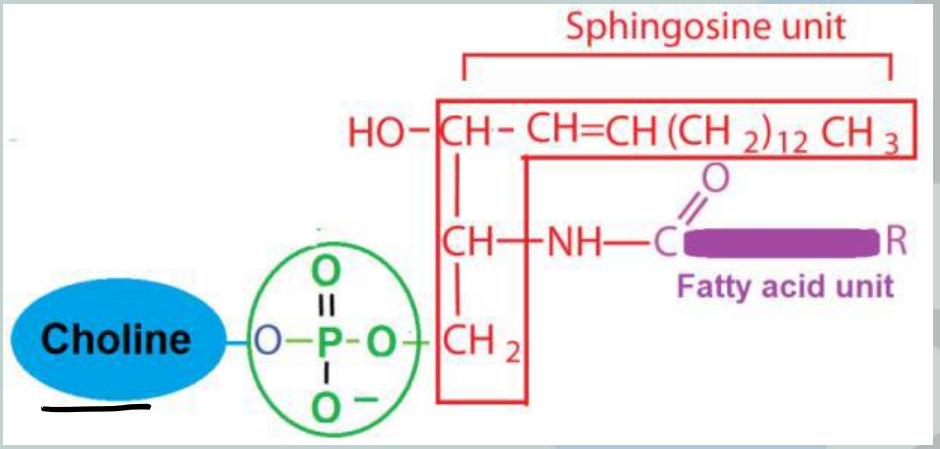
Ceramide
- Synthesis in SER

Polar Group
- Phospho
- Sugar

addition occurs in Golgi

Sphingolipids
- Eukaryotes only
- only on extracellular side

Sphingomyelins — Phospho - Sphingolipid

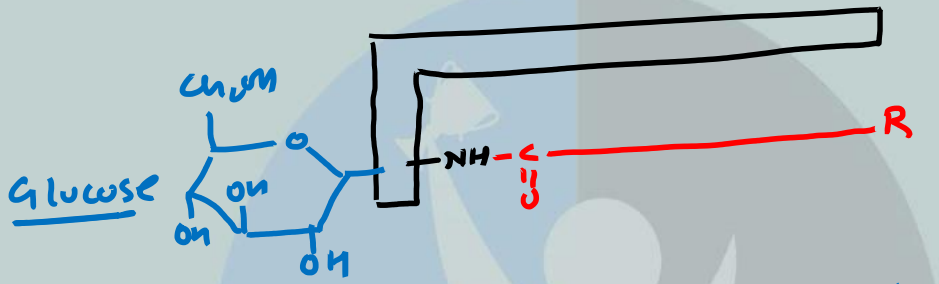


1 choline + 1 phosphate + 1 sphingosine + 1 FA

- Abundant in neural membrane & mylein sheath.
- Exoplasmic face of membrane

D. Glyco-sphingolipids:

Cerebroside:



Ceramide + monosaccharide : cerebroside

eg → Gluco-cerebroside
Galacto-cerebroside

oligosaccharide

Globoside: A **globoside** is a type of glycosphingolipid with more than one sugar

Gangliosides are complex glycosphingolipids derived from glucosylceramide that contain in addition one or more molecules of a **sialic acid.** (N-acetyl-D-Neuraminic acid)

GM – monosialate

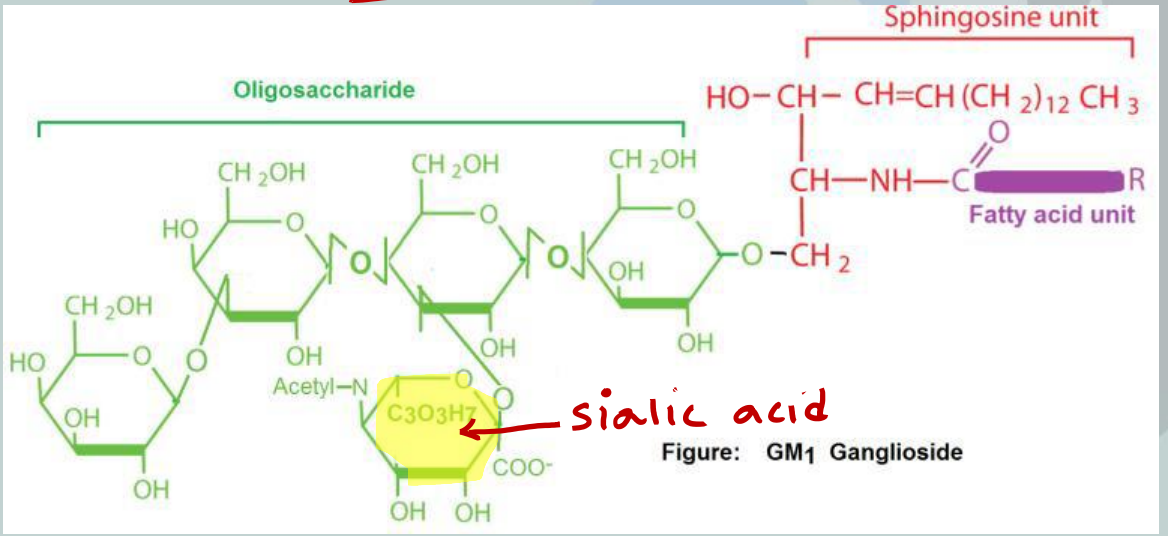


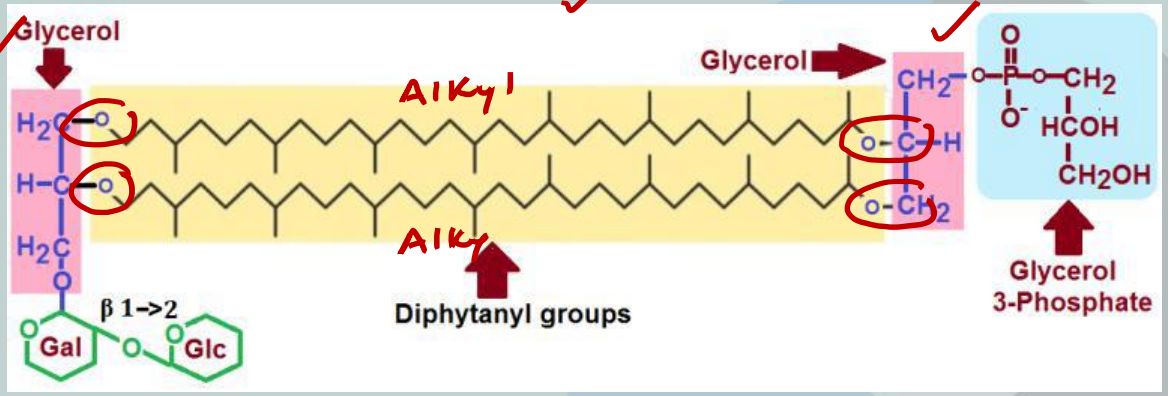
Figure: GM_1 Ganglioside

GM_1 Ganglioside: Receptor for cholera toxin

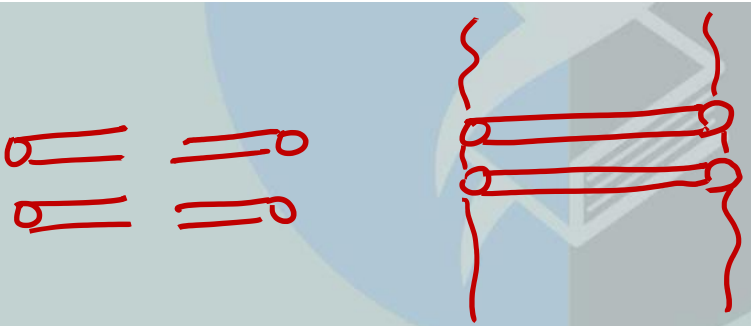
GM_2 Ganglioside: accumulates in Tay-sach disease

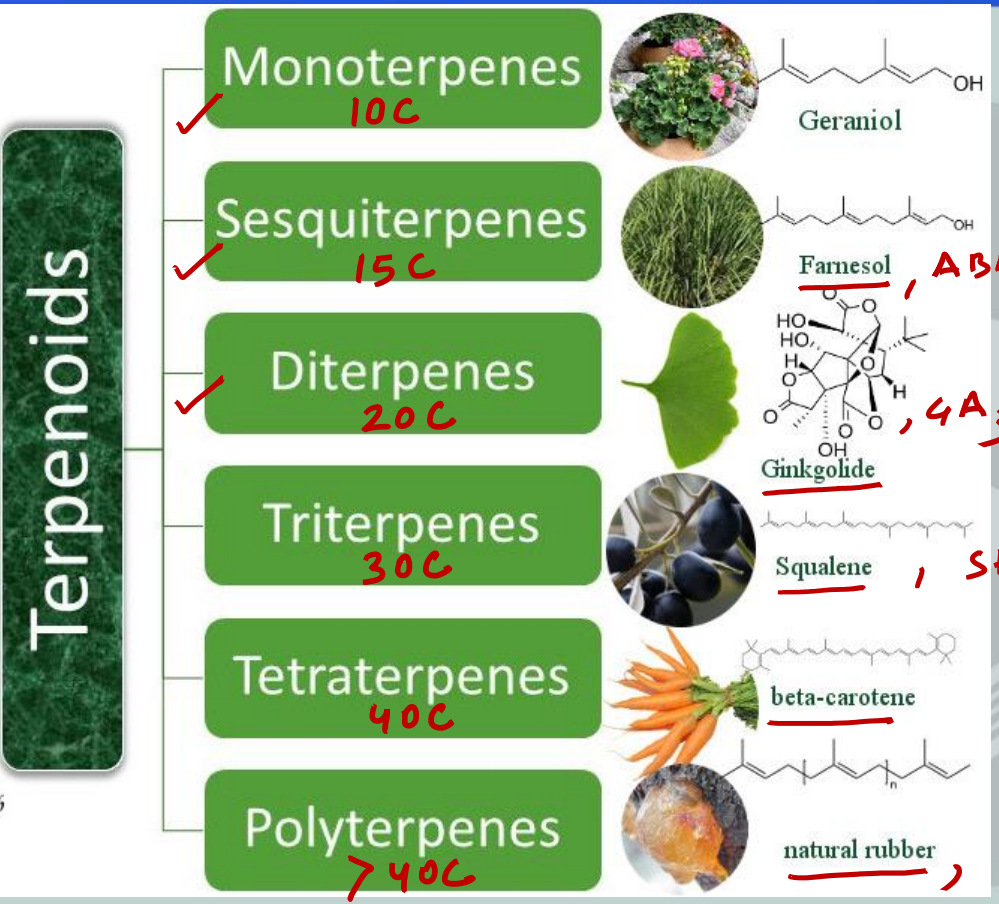
GM_3 Ganglioside: Receptor for influenza virus

Archaebacterial glycerol dialkyl glycerol tetraether:



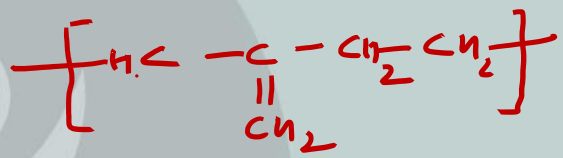
- Branched aliphatic chain
- Ether bond.
- L- Glycerol Pro- chiral form.





Terpene:
- Primary : ABA, GA_3, sterol
- Secondary : Rubber, steroids

Formed from combinations of two or more molecules **isoprene** (a five-carbon unit).



, ABA

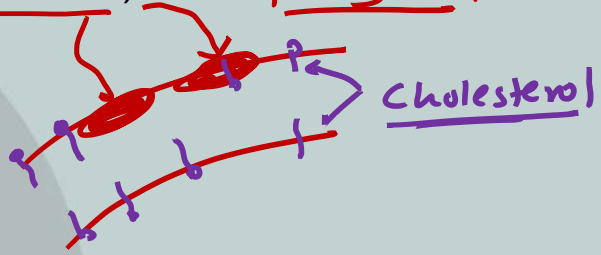
, GA_3

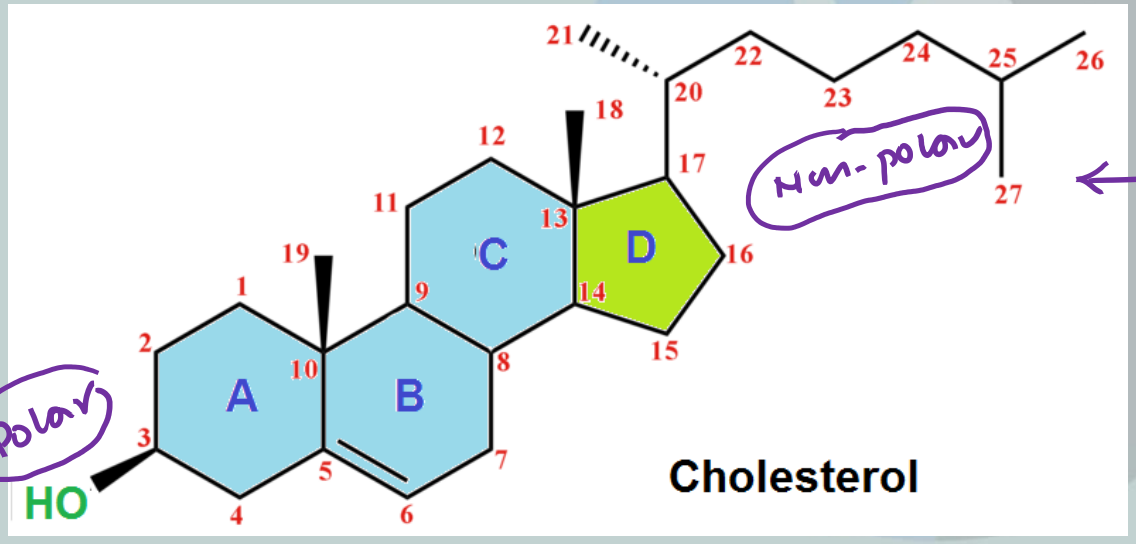
, sterol, steroids

Quinone
Dolichol.

Cholesterol : unique sterol of animals derived from squalene (triterpene)

- Principal component of animal cell plasma membranes (lipid rafts). + sphingolipids
- Provides **rigidity**
- **Temperature buffer**.
- It **donot** influence Tm → depends on FA





Non-polar

Ampipathic molecule

Lipid storage diseases

Autosomal Recessive
Genetic Disorder
Gene mutation
Enzyme absent ↓

← Accumulation in Lysosome

1. **Nieman-pick disease:** Sphingomyelinase

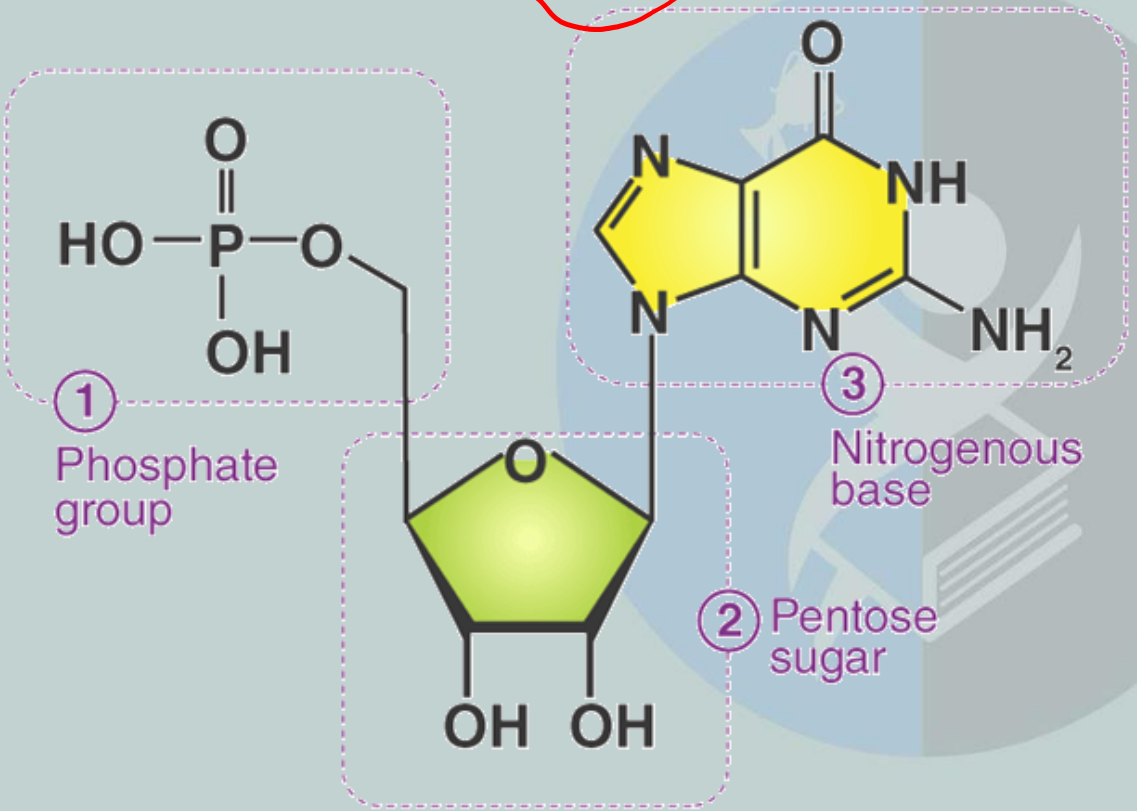
2. **Gaucher's disease:** Glucocerebrosidase

3. **Tay-Sach's disease:** Hexoseaminidase or GM_2 - Gangliosidase

NUCLEOTIDES AND NUCLEIC ACIDS

What are nucleotides?

Atleast 1 Phosphate + 1 Sugar + 1 Base

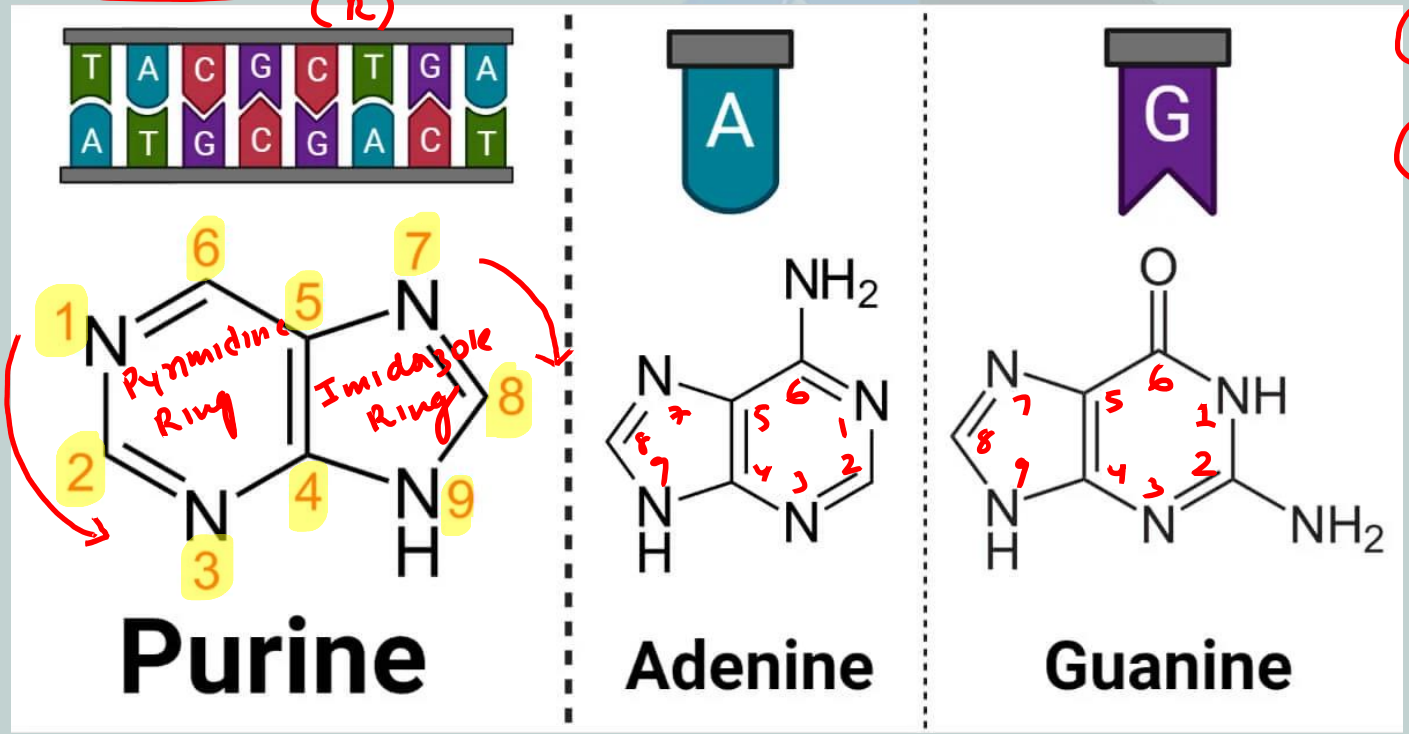


What are functions of nucleotides?

1. Building blocks of nucleic acids (DNA and RNA).
2. Involved in energy storage, muscle contraction, active transport, maintenance of ion gradients – ATP, GTP, CTP, UTP.
3. Activated intermediates in biosynthesis (e.g. UDP-glucose, S-adenosylmethionine).
4. Components of coenzymes (NAD+, NADP+, FAD, [redacted], and CoA)
5. Metabolic regulators:
   - Second messengers (cAMP, cGMP)
   - Phosphate donors in signal transduction (ATP)
   - Regulation of some enzymes via adenylation and uridylylation

Nitrogenous Bases

1. Purine : Double heterocyclic Ring, weak base, non-polar

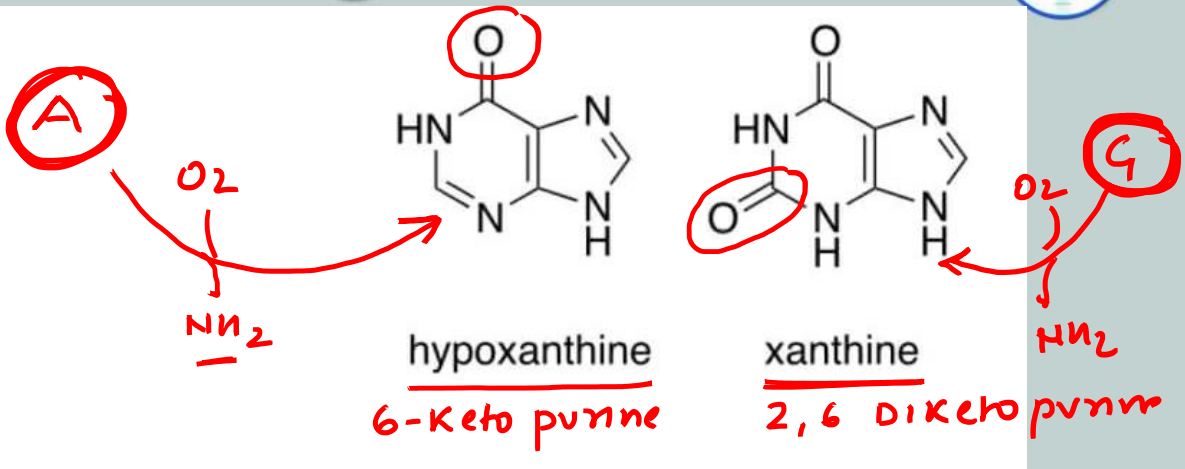


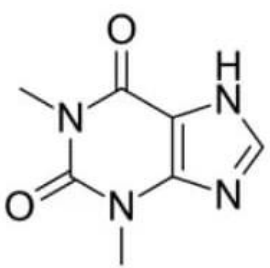
A 6-Amino Purine

G 2-Amino 6-keto purine

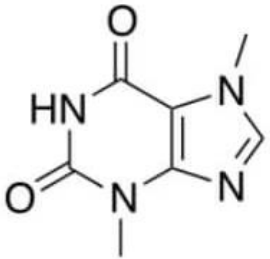
R
Purine
A
G

Purine Derivatives

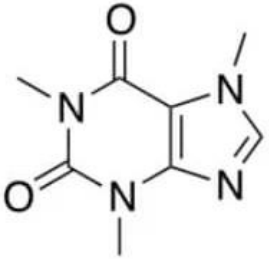




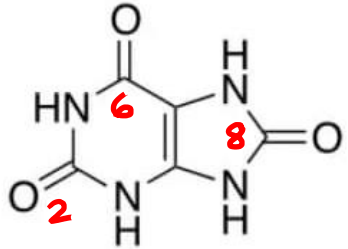
theophylline



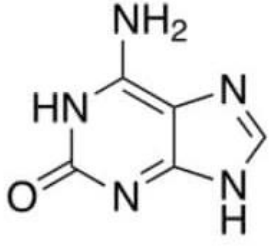
theobromine



caffeine



uric acid



isoguanine

Pyrimidine (Y)

Thymine

(DNA Only)

common in

Rare in RNA

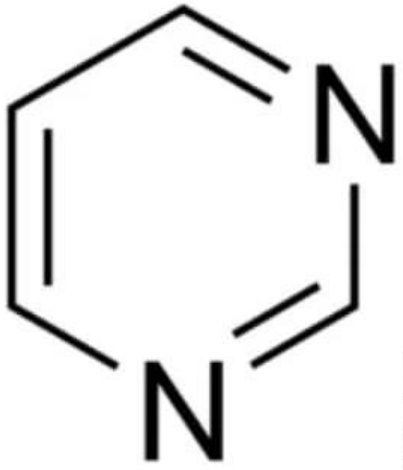
Uracil

(RNA Only)

common

• Rare in DNA

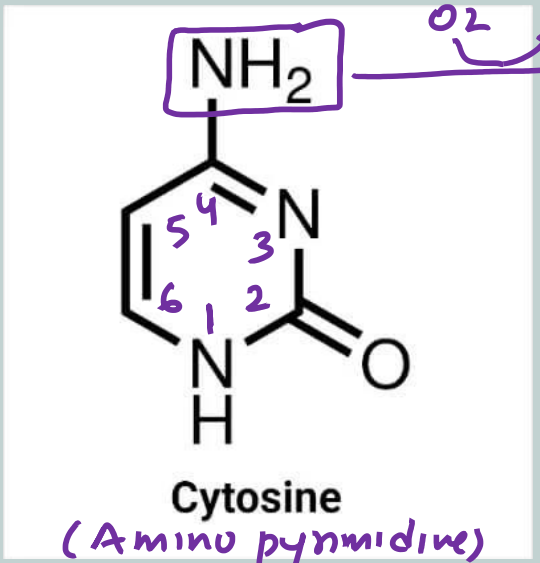
Cytosine

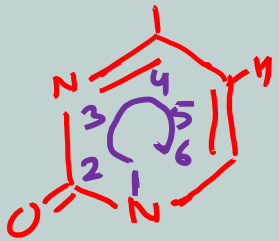


Pyrimidine Structure

(4C & 2N)

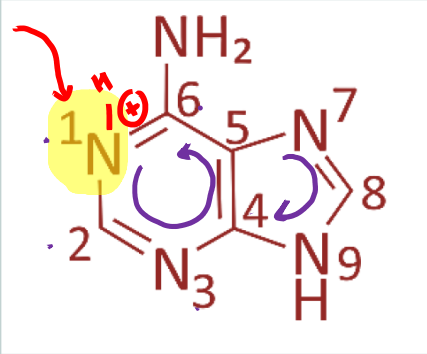
← Diazine Ring


NH2
O2
NH2
O
NH
N
H
Cytosine
(Amino pyrimidine)
Uracil
H3C
Thymine
(5-methyl uracil)



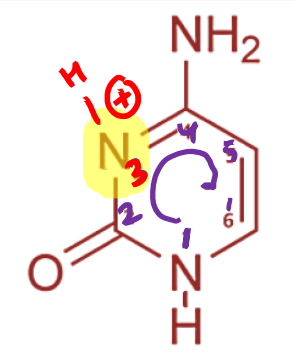
Site of Protonation

strong acidic condition (pH ≅ 3)

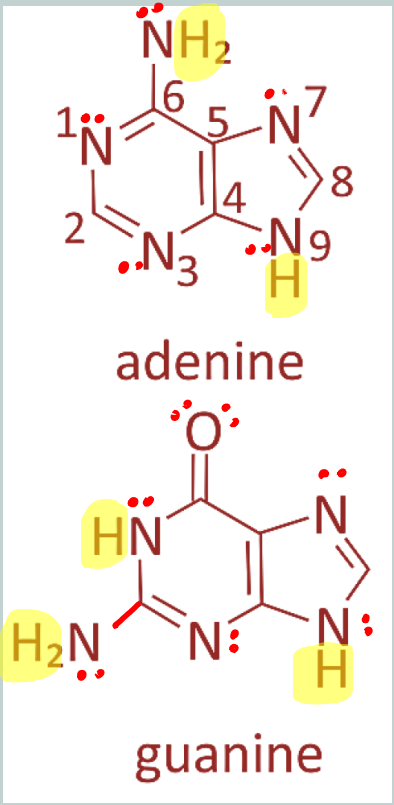


Purine : N 1

Pyrimidine : N 3



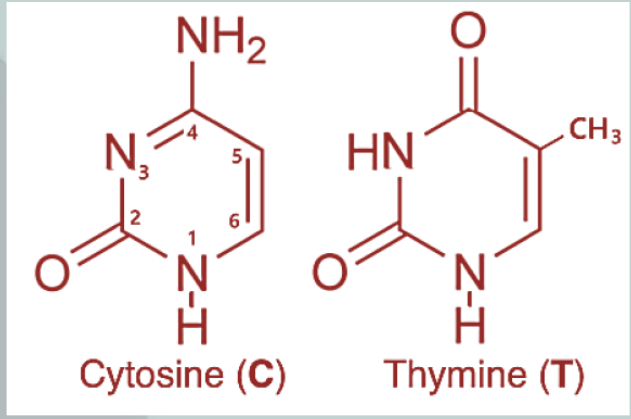
Maximum Hydrogen bond capability



- Guanine
  - various lone pairs
  - H- Donor group.

A = T or A = U

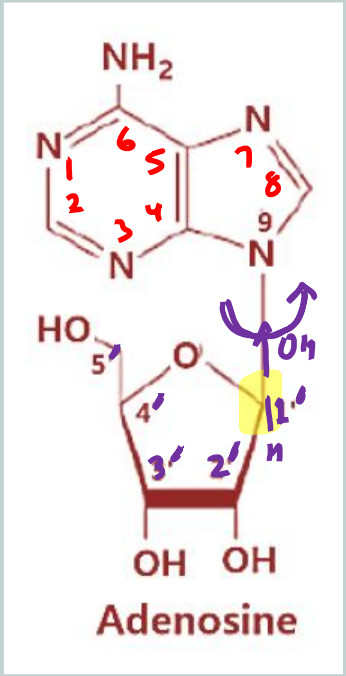
G ≡ C

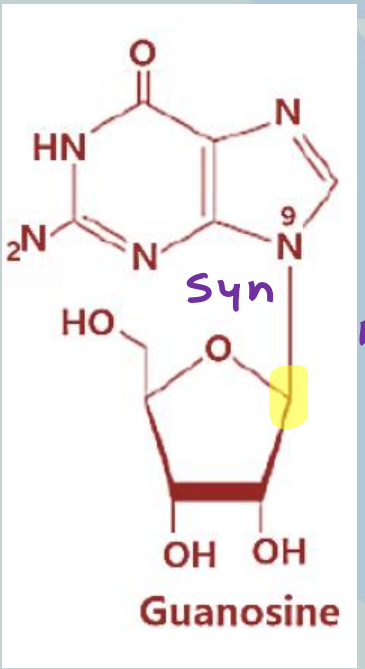


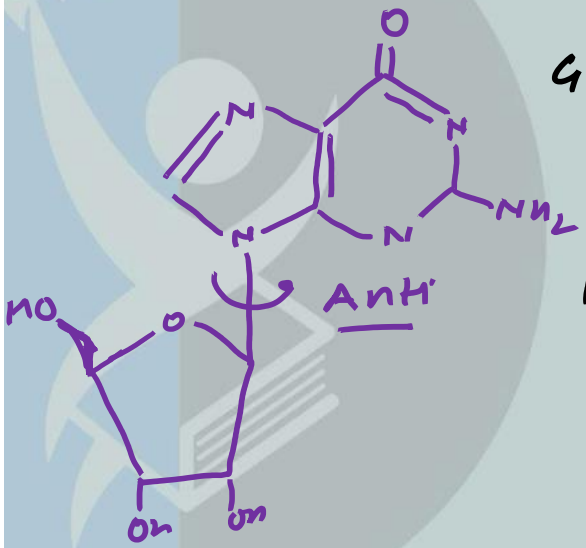
Purine Nucleoside : Base + Ribose sugar

Anti / Syn

- β 1′ → N9 Glycosidic bond







Adenine + Ribose = Adenosine

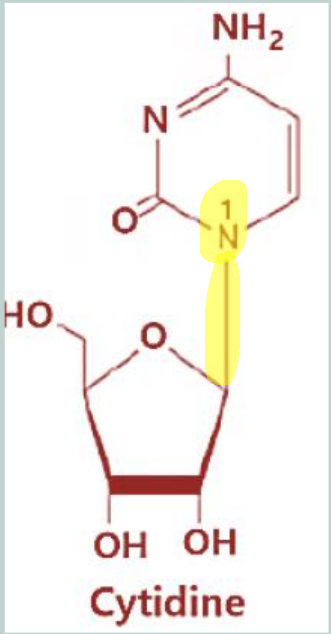
Guanine + Ribose = Guanosine

Xanthine + Ribose = Xanthinosine

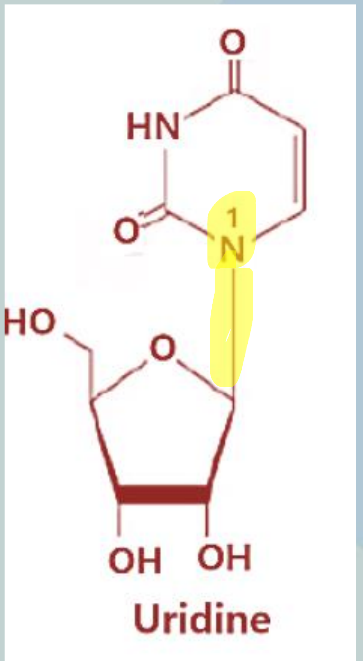
Hypoxanthine + Ribose = Inosine

Pyrimidine Nucleoside : β 1' → N1 Glycosidic bond (Anti/Syn)

- Cytosine + Ribose = Cytidine
- Uracil + Ribose = Uridine
- Thymine + Ribose = Thymidine

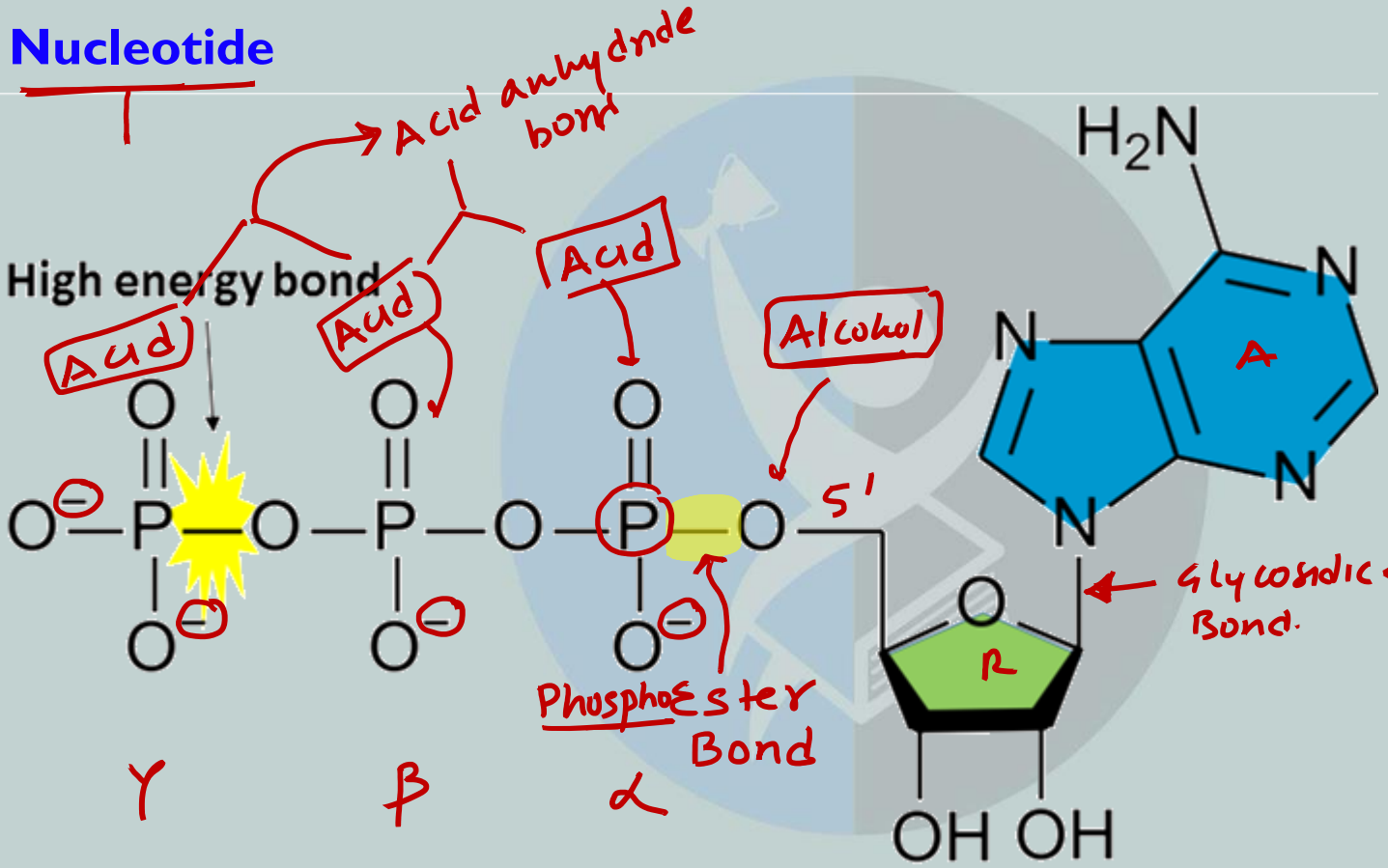


Cytidine



Uridine

Nucleotide



AMP (-2)

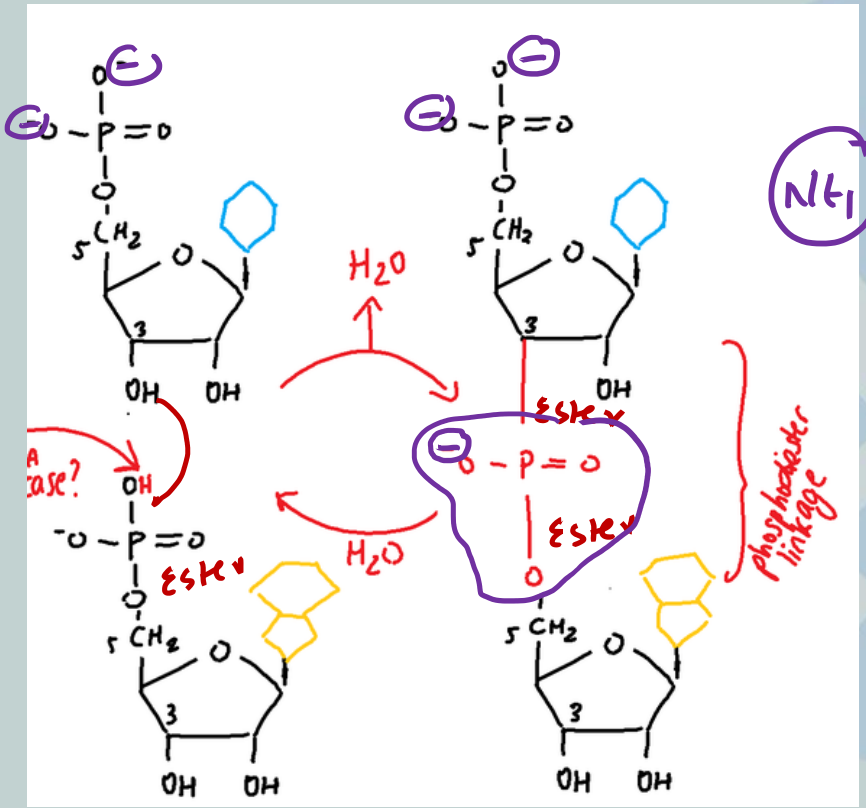
ADP (-3)

ATP (-4)

Polynucleotides: 5'-pGpApTpC-3'.

-2 -1 -1 -1

pH = 7
Charge = -5



- Phosphodiester bond

NT1 — 3'-OH + Phosphoric Acid + 5' OH — NT2

3' Ester

5' Ester

PPP N p N p N p N

-4 -1 -1 -1

= -7

→ RNA polymerase
→ DNA polymerase

Average molecular weight

Nucleotide = 330 Dalton (g/mole)

Nucleotide pair (bp) = 660 Dalton (g/mole)

} Part of nucleic acid

- 100 nt ss RNA, MW = ?

  100 × 330 D = 33000 D = 33 KD

- 100 bp DS DNA, MW ?

  100 × 660 D = 66000 D = 66 KD

www.ifasonline.com

thank you

Learn From India's Best Educators

India's **No.1** EdTech Company for Graduates
& Post Graduates Examination.

Download **IFAS** App Now

ANDROID IOS WINDOWS

IfAS

Harshada Sharma

Earned: ₹25,500

"As is widely recognized, IFAS stands as India's leading institute for CSIR NET examination preparation. My Personal philosophy has always revolved around helping others and I've had the pleasure of introducing the IFAS Online Course to 12 of my classmates and juniors, which in turn allowed me to earn 25,500 rupees. You too can join in and refer your friends, allowing you to earn a 5% rewards based on the fees each of your referred friends Pay"

REFER & EARN

Step – 01 Invite Friends

Share your referral code or Link with your friends.

Step – 02 Earn Cashback

On Every Purchase made using your referral code, you earn 5% instant cashback in your bank account.

Step – 03 Refer More, Earn More

Keep referring as many friends as you can and keep **Earning** cash as much as you can

Friendship is Sharing, Caring, Giving & Helping Each Other...!